Water Resources

Alberta
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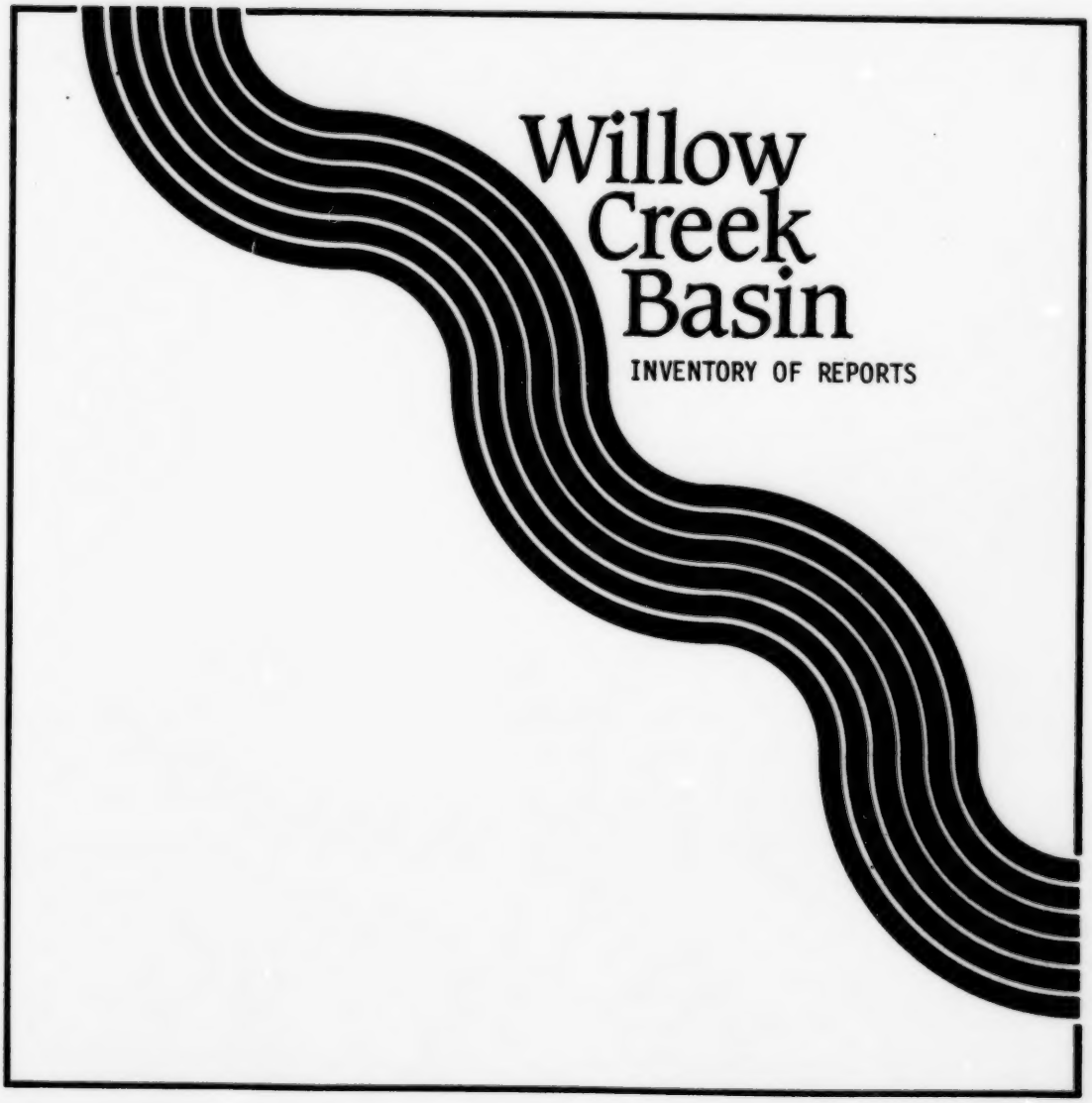
Willow
Creek
Basin
INVENTORY OF REPORTS

WILLOW CREEK BASIN STUDY - Inventory of Reports

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WILLOW CREEK BASIN STORAGE SITE FEASIBILITY INVESTIGATIONS

Submitted by: D. Hart, P. Eng., Alberta Environment, Calgary
Prepared by: L. K. Szojka, P. Eng., Alberta Environment, Lethbridge
November 1985

Feasibility studies were carried out for six potential storage projects in the Willow Creek Basin:

Site 1.	Claresholm Site	- 32,000 acre-feet
Site 2.	Pine Coulee (Offstream) Site	- 41,000 acre-feet
		- 20,000 acre-feet
	Willow Creek (Onstream) Site	
Site 3.	Kuntz Creek Site	- 48,000 acre-feet

Evaluation of the projects were based on physical, economic, environmental and social considerations. The most feasible project from all considerations is a 41,000 acre-foot offstream storage reservoir at Site 2, Pine Coulee, at a total cost of $34.0 million. This project would provide a more secure water supply for municipal needs, meet stockwatering needs along the creek, and provide a source for pumping under emergency conditions, meeting existing irrigation needs and provide for some expansion, and enhance fishery and recreational pursuits. The 41,000 acre-foot Pine Coulee project has considerable local support.

A smaller 20,000 acre-foot offstream project could be constructed in Pine Coulee for about $21.9 million. The smaller project would support less irrigation and, from an economic viewpoint, would be less attractive than the larger one.

Field investigations for the onstream dams at Sites 1 and 3 were not carried out because of opposition from landowners. However, on the basis

STORAGE SITE FEASIBILITY INVESTIGATIONS (cont'd.)

of available information on these two sites and from investigations of the Willow Creek Site 2 onstream dam near Pine Coulee, there appears to be no particular advantages to the onstream sites over the Pine Coulee site. The Site 2 onstream project would cost about as much as the offstream Pine Coulee project (with comparable storage capacity) and would have greater environmental and social impacts.

Based on this investigation, it is concluded that a 41,000 acre-foot offstream storage project at the Pine Coulee site is the most feasible project for multipurpose water use in the Willow Creek Basin.

INVENTORY REPORTS

FINAL REPORT, PRELIMINARY PLANNING STUDY, WILLOW CREEK BASIN, INVENTORY OF STORAGE SITES

Kohn Leonoff Consulting Engineers, June 1985

The objective of this preliminary planning study was to identify potential onstream and offstream water storage sites in the Willow Creek drainage basin and to determine the order of magnitude costs to develop the sites. The study was, in essence, an office study based on available information including previous reports, topographic maps, air photos, streamflow data, hydrological reports and geological reports, augmented by a site reconnaissance.

It was agreed, upon discussion with Alberta Environment, that a total of six potential storage sites would be selected from those identified in the initial stages of the study for more detailed assessment and comparison.

Site 1 - Pulteney
Site 2 - Pine Coulee
Site 3 - Kuntz Creek
Site 4 - Junction
Site 5 - South Willow Creek
Site 6 - Trout Creek

On the basis of very preliminary assessments, it would appear that Sites 1, 2 and 3 are the most suitable. Of these, Sites 1 and 2 appear to have the best potential.

Although the Pine Coulee Reservoir provides less than the targeted flow regulation capacity of 60 per cent mean annual runoff, the regulated release rates would still be higher than most of the other sites. This site also has the advantage of requiring no major spillway or diversion works and, would not have an adverse impact on fish resources. It does have a greater sociological impact than Site 3 because the reservoir will affect five farmsteads, flood one farmstead and four roadways.

INVENTORY OF STORAGE SITES (cont'd.)

The Kuntz Creek Reservoir capacity is sized for the full targeted flow regulation of 60 per cent mean annual runoff so the potential regulated release rate is higher than any of the other sites. Reservoir damages are comparatively small, flooding only one large farmstead. The reservoir area is not classified as a Wildlife Key Area but Willow Creek in that vicinity supports rainbow trout, eastern brook trout, mountain whitefish and suckers.

The report recommends that more detailed studies be undertaken to assess potential storage areas in the basin.

ECONOMIC REPORT

PRELIMINARY FINANCIAL AND ECONOMIC ANALYSIS OF STORAGE ALTERNATIVES IN THE WILLOW CREEK BASIN

Marv Anderson & Associates, November 1985

This report contains the results of a preliminary financial, economic and socio-economic analysis of the four storage alternatives in the Willow Creek Basin. It is based primarily on irrigation and does not take other uses into consideration. The four sites considered were:

Site 1 - Pulteney
Site 2 - Pine Coulee
Site 3 - Kuntz Creek
Site 4 - Junction

The farm financial implications are largely dependant upon a farmers' particular circumstances, however, in general, irrigated agriculture has a comparative advantage over dryland agriculture.

The net return to irrigation development in the Willow Creek Basin would be very similar irrespective of which proposed reservoir site was selected. Considering economic returns from irrigation alone, it is not possible to definitively rank the respective reservoirs.

From a socio-economic perspective (which considers the spinoffs from proposed irrigation development), all of the proposed reservoirs appear to be viable investment opportunities irrespective of any net benefits to the province other than those generated by agriculture related activities.

ENVIRONMENTAL/SOCIAL REPORTS

WILLOW CREEK RESERVOIR DEVELOPMENT, LOCAL CONCERNS INVENTORY

LGL Limited, January 1986

This report identifies and discusses local concerns regarding the potential development of a water storage site within the Willow Creek Basin.

For the purpose of this study, the sites under consideration are referred to as:

Site 1 - Pulteney
Site 2 - Pine Coulee
Site 3 - Kuntz Creek
Site 4 - Junction

These sites are situated on the Willow and Pine Creeks along the eastern perimeter of the Porcupine Hills.

Twenty-two landowners were surveyed, the majority of which have lived in the area longer than 10 years, mostly in their current homes. Of these, 15 respondents want the development to proceed, three do not and four have no preference either way.

The most common concerns identified were the loss of productive land and, for some, the loss of their homes. Solutions suggested by the respondents include:

- a reasonable compensation program
- choice of a site other than the one affecting them
- access to irrigation licenses

LOCAL CONCERNS INVENTORY (cont'd.)

The majority of interviewed landowners indicated that their current operations and future plans are being affected by the discussion of a potential storage site. Ten respondents have placed all plans on hold until such time as a decision is reached on the location and development of the reservoir.

Irrigation was identified as the major purpose of the project, followed by municipal use. Recreational development was considered secondary to the others.

Historical resources in the area were indicated to be important to at least half the individuals and their communities. Respondents were also concerned about the affects on fish, wildlife and vegetation.

While only 14 per cent of those interviewed were ever affected by water quality changes in Willow Creek, the majority had noted that Pine Coulee has dried up the last seven summers, as did Willow Creek in 1984.

The Pine Coulee and Junction Sites received the best support but no clear majoirty was in favor of a specific site under consideration.

OVERVIEW ENVIRONMENTAL ASSESSMENT OF FOUR POTENTIAL RESERVOIR DEVELOPMENTS ON WILLOW CREEK

LGL Limited, November 1985

To aid in site evaluation and selection for a water storage reservoir in the Willow Creek Basin, the environmental overview provided an inventory of information on wildlife, fisheries, geology, soils, land use, historical resources and water quality issues in the area.

The four sites on the Willow and Pine Creeks, along the eastern perimeter of the Porcupine Hills are identified as follows:

Site 1 - Pulteney
Site 2 - Pine Coulee
Site 3 - Kuntz Creek
Site 4 - Junction

Included in the reports findings are:

Wildlife

The four sites were assessed based on known utilization by wildlife and habitat potential. Site 3 was rated as the most vulnerable to project impacts because it supports high quality habitat for both terrestrial and aquatic species. Sites 1 and 4 were ranked second most vulnerable and Site 2 was rated the least vulnerable.

Fisheries

The four prospective reservoir developments were evaluated based on existing fisheries and their potential for creating new fisheries. Dam

construction at Sites 1 and 4 would affect the habitat and migration capabilites of cool water fish in those areas. Fish species in the area of Site 3 would be moderately affected and there are no current fisheries at Site 2.

Sites 2 and 4 have the greatest potential as reservoir fisheries because the large water storage area in Pine Coulee would have a low turnover rate and more suitable morphology for fish production.

Geology, Soils, Land Use

Geology of the study area generally consists of Tertiary and Cretaceous sandstones and shale. Soils have developed on glacial till, glacio-fluvial or fluvial sediments. Site 2 has the least potential for erosion problems, while Site 3 has the greatest because of its steep-walled topography.

Flooding would predominantly affect private lands and agricultural activity at the four sites. Site 4 development would result in the largest area of bottomland being inundated, including the loss of Willow Creek Provincial Park.

Historical Resources

Sites were evaluated based on their known historic, prehistoric and palaeontological significance and their potential for harbouring as yet undetected historical resources. Information collected represents mere inventory data. Sites haven't been assessed for their local and regional significance.

OVERVIEW ENVIRONMENTAL ASSESSMENT (cont'd.)

The combined historical, prehistorical and palaeontological potential of Site 1 makes it most vulnerable to project impacts, followed by Sites 4, 3 and 2 respectively.

Water Quality

From a water quality perspective, reservoir developments at Sites 1 and 3 would be preferable. Shallower mean depth and lower flushing rates of reservoirs at Sites 2 and 4 will likely result in mesortrophic to eutrophic conditions, increased plan and algae growth and reduce water clarity.

All sites would experience an initial trophic upsurge during reservoir formation and downstream taste and odor problems in drinking water may result. These will be short-lived problems at Sites 1 and 3 because of high on-stream flushing rates.

WATER STUDY REPORT

NATURAL FLOWS FOR WILLOW CREEK BASIN

Alberta Environment, Water Resources Management Services, Technical Services, Technical Services Division, Hydrology Branch
June 1985

This report presents the method and results of a study to develop monthly mean natural flows, from 1912 to 1983, at seven hydrometric station locations and four points of interest within the Willow Creek Basin. The purpose of this study was to assess the potential success of selected water management alternatives by superimposing them on the historical period.

The basin geography, the analytical approach of the study, water use within the basin, and the derivation of histrocial natural flows at both gauging locations and ungauged potential water storage sites are included in this study report.

The natural flows for the hydrometric station locations were derived from streamflow records, reservoir data, recorded project water use information and climate area.

ENGINEERING REPORTS

WILLOW CREEK PROJECT, PINE COULEE RESERVOIR, GEOTECHNICAL DESIGN REPORT, LEVEL 1

Alberta Environment, Design and Construction Division, Geotechnical Branch
November 1985

This report contains a preliminary design and feasibility assessment together with a cost estimate for an off-stream storage reservoir within the Pine Coulee along with the associated diversion works from Willow Creek.

The major components associated with the development of this storage reservoir include:

- construction of an earth dam across the downstream end of Pine Coulee
- a saddle dyke along the southeast periphery of the proposed reservoir
- a major causeway at the Highway 527 coulee crossing
- a minor causeway crossing near the northern boundary of the reservoir

In addition, the major components associated with the diversion works from Willow Creek include:

- construction of a diversion weir on Willow Creek
- a diversion headgate structure
- a diversion channel
- the Pine Coulee reservoir inlet structure

The results of this preliminary study indicate that construction of the proposed earthfill dam across the downstream end of Pine Coulee is geotechnically feasible. The report summarizes the major geotechnical aspects associated with the preliminary design of this project and identifies some specific areas requiring additional study. Most of these studies deal with the availability and suitability of materials required

for the construction of this project. Other studies recommended include the assessment of environmental concerns, installation and operational details, and costs.

The preliminary cost estimate for the overall Pine Coulee Reservoir Project is $29.5 million. This includes a 15 per cent contingency allowance but does not include any provision for engineering costs.

WILLOW CREEK PROJECT, PINE COULEE RESERVOIR, GEOTECHNICAL DESIGN, EXECUTIVE SUMMARY

Alberta Environment, Design and Construction Division, October 1985

This report identifies the major components for the Pine Coulee off-stream storage reservoir along with the associated diversion works, and includes a cost estimate for the project.

The major components associated with the development of this storage reservoir are:

- construction of an earth dam across the downstream end of Pine Coulee
- a saddle dyke along the southeast periphery of the proposed reservoir
- construction of a major causeway for the Highway #527 crossing
- a minor causeway crossing near the northern boundary of the reservoir

In addition, the major components associated with the diversion works from Willow Creek include:

- construction of a diversion weir on Willow Creek
- a diversion headgate structure
- a diversion channel
- the Pine Coulee reservoir inlet structure

The proposed Pine Coulee dam would be approximately 21 m in height and 450 m in length across its crest. It would be located about 400 m upstream of the confluence of Pine Coulee and Willow Creek. The resulting reservoir would be approximately 12 km in length and would cover some 6.0 km^2 in area.

GEOTECHNICAL DESIGN, EXECUTIVE SUMMARY (cont'd.)

Geotechnical consideration for the remaining components of the project are relatively standard and no unusually complex or expensive features will be required.

The estimated total cost of the overall project is $29.5 million. This includes a 15 per cent contingency allowance but not any provision for engineering costs.

Further detailed investigations are required for the final project design.

HYDROGEOLOGICAL ASSESSMENT OF THE PROPOSED PINE COULEE RESERVOIR
Piteau Engineering Ltd., October 1985

This study assesses the hydrogeological conditions in the proposed Pine Coulee Reservoir area including: the groundwater chemistry; potential water losses from the reservoir into the surrounding geological formations; the distance at which groundwater surface elevations will be affected by reservoir impoundment; and, the areas where local flooding may occur as a result of rising groundwater surface elevations.

The entire site appears to be lined with a low hydraulic conductivity silty clay of glacial or alluvial origin. The underlying bedrock was tested twice for hydraulic conductivity and had a low K.

The Stavely Buried Channel was tested twice during the field program and was found to be a confined aquifer which is overlain by low hydraulic conductivity silty clay, which likely hydraulically separates it from the proposed reservoir. However, the extent and hydrogeological properties of the channel are unproven and it may have the potential to act as a drain if a hydrogeological window opens to the reservoir.

Water losses from the reservoir into surrounding geological formations would be primarily through the valley bottom and should not exceed 0.14 m^3/s. Water losses through the valley walls and underneath the east bank dyke area will likely be less than 1.0×10^{3} $m^3/2$.

A rise in groundwater surface elevations will occur in the areas adjacent to the reservoir and will be less than the maximum depth of 21 m of the reservoir. Due to the low hydraulic conductivity values of the surrounding geological formations, the radius of influence of the reservoir on the groundwater surface elevation should be limited to, at most, several hundred metres.

HYDROLOGICAL ASSESSMENT (cont'd.)

Flooding in areas adjacent to the valley will not likely be a problem due to the high ground surface relative to the proposed reservoir level. East of the proposed bank dyke, where the ground and groundwater surface is lower than the reservoir level, minimal seepage may occur. If a proper drainage system is constructed, any near surface and surface flow can be intercepted and flooding will likely not occur.

The quality of the groundwater surrounding the reservoir will likely be minimally affected by the introduction of new water to the groundwater regime and by seasonal fluctuations in the reservoir level.

No serious negative hydrogeological impact of the reservoir on the surrounding area was identified. In general, the hydrogeological conditions should be considered favorable for the proposed reservoir. Slope stability considerations, possible effect of the reservoir on the dam and seepage through the dam foundations and abutments were not addressed in this study.

Further testing was recommended for a few specific hydrogeological areas both before and after the construction of the proposed project.

WILLOW CREEK BASIN HYDROLOGIC ASSESSMENT OF RESERVOIR ALTERNATIVES

Alberta Environment, Water Resources Management Services, Technical Servics Division, Hydrology Branch

November 1985

A hydrological assessment was performed on four reservoir alternatives in the Willow Creek Basin. The assessment was based on the effects of the reservoirs on the monthly streamflow data of the Willow Creek basin for the period 1912 to 1983. Three independent options were examined for each alternative. The first option represented those optimum conditions for which agricultural demands were met with 100 per cent reliability for the period of the record. The second and third options represented those conditions for which 95 per cent and 90 per cent reliability rates occured, respectively.

Two computer models were developed to assist in this assessment. The assumptions, procedures and results of the models are presented and discussed in this report. The overall results, summarized as storage-draft curves, are also included.

WILLOW CREEK BASIN, PINE COULEE RESERVOIR, ALTERNATIVE 1, OFF-STREAM STORAGE, CONCEPTUAL DESIGN REPORT

Alberta Environment, Water Resources Management Services, Design & Construction Division, Design Branch
November 1985

The report presents the conceptual design on water storage in the Pine Coulee, an off-stream site identified for flow regulation in the Willow Creek Water Basin.

Water can be stored in the coulee by a main embankment dam located at about the old PFRA site and a saddle dyke. Flow from the Willow Creek will be raised by a weir and conveyed to the reservoir through a high level diversion canal. The canal headgates will regulate the diverted flow and protect the canal works from Willow Creek floods. A reservoir inlet of baffle apron type will assure a safe discharge of the diverted flow into the reservoir under all flow conditions.

Highway 527 and the road along the boundary of Township 14 will be raised above the reservoir full supply level. Existing culvert structures will be extended and upgraded to accommodate the two-way flow conditions. Rock riprap protection will be provided at the upstream slope of the main dam, the saddle dyke and at both slopes of the highway and road crossings.

The flow regulation capability is about 58 per cent of the mean annual runoff at the diverted site. Water uses from the reservoir can be made by gravity diversion, pumping and downstream release through a low level outlet located at the left bank of the dam.

The project can be constructed in three consecutive years. During the construction, flow of the Pine Coulee could be handled by the low level outlet. At the diversion weir site, the concrete section and the

ALTERNATIVE 1 (cont'd.)

dyke will be constructed first, on high ground. Closure of the creek bed will be make while diverting the creek flow through the completed concrete section.

The total project cost is revised at $29.5 million including a 15 per cent contingency allowance. This corresponds to about $737/acre feet.

The designs and cost estimates presented in this report are of conceptual nature and intended specifically to establish the order of magnitude costs and the general arrangement of the works. Considerable design works will be required before structural arrangement can be firmed up and details worked out.

WILLOW CREEK BASIN, PINE COULEE RESERVOIR, ALTERNATIVE 2, ON-STREAM, STORAGE, EXECUTIVE SUMMARY

Alberta Environment, Water Resources Management Services, Design & Construction Division, Design Branch

November 1985

This summary highlights the design component prepared under the frame work of a feasibility study on water storage in Pine Coulee. The on-stream Junction Site alternative consists of:

- a dam embankment on Willow Creek at a site about 200 m downstream of the junction with Pine Creek
- a saddle dyke along the southeast periphery of the reservoir
- two major crossings of Pine Coulee and Willow Creek for Highway 527
- a minor coulee crossing for the east/west road near the northern end of the reservoir

Other structures associated with the dam embankment are the service spillway located at the right abutmnet, the outlet works located at the left abutment and the emergency spillway incorporated with the saddle dyke. Horizontal and vertical alignments of dykes and dam will have the same equivalence of a rural market road.

Total project cost for the Junction Site is estimated at $34.5 million including a contingency provision of 15 per cent to reflect the preliminary design stage. Cost per acre/feet stored is estimated at about $600. Engineering costs are not considered in this estimate.

WILLOW CREEK PROJECT, PINE COULEE RESERVOIR, CONCEPTUAL DESIGN, INTERIM REPORT

Alberta Environment, Design & Construction Division
August 1985

This is an interim report on the conceptual design of the Pine Coulee Reservoir within the context of the feasibility study of water storage in the Willow Creek Basin.

The structures arrangement is the same as proposed in the planning report, consisting of:

- an embankment dam at Pine Coulee
- a saddle dyke at the northeast end of the main dam
- a diversion weir on Willow Creek
- a diversion canal complete with headgates and reservoir inlet
- a major causeway at the coulee crossing of Highway 527
- a minor causeway at the coulee crossing along the northern boundary

The report offers technical suggestions as to the construction of the various components of the dam and associated diversion works, as well as several options.

The cost estimate for the total project is $27.5 million. This estimate includes site services costs, construction costs, road relocation, reservoir and land costs, and a contingency provision of 20 per cent to reflect the conceptual design stage.

WILLOW CREEK FEASIBILITY STUDY, CONCEPTUAL DESIGN COST
Alberta Environment, Design & Construction Division
August 1985

This is a status report updating the conceptual designs and cost estimates for the three dams being considered in this study.

Site 1 - Pulteney

Since the last status report of March 4, 1985:

- Storage capacity curves have been developed using a new 2.5 m contour mapping of the reservoir area.

- The engineering design cost estimate was updated to reflect the most recent revisions to unit costs. It is now $24 million which includes a 30 per cent contingency allowance.

Site 2 - Pine Coulee

There has been a considerable amount of engineering design completed for this alternative since March 1985. The updated design data for the proposed dam, associated structures and reservoir are included in this report. The revised cost estimate, including a 20 per cent contingency, is $27.5 million.

Site 3 - Kuntz Creek

Due to land access difficulties, there have been no new mapping or foundation investigations performed for this alternative. Including a 40 per cent contingency allowance, the cost estimate for the Lane Creek Site is $25 million.

CONCEPTUAL DESIGN COST (cont'd.)

The accuracy of the information presented in this report for the Pine Coulee Site is more precise than that of the other two sites but the preliminary design of this alternative is still in progress and some modifications will almost certainly have to be made in the future.